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Psathyra urticaecola
Coprinus plicatilis
Psathyrella disseminata

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SOME CRITICAL REMARKS ON THE GENERIC POSITIONS OF PSATHYRA URTICAECOLA BERK. ET BROOME, COPRINUS PLICATILIS FR., AND PSATHYRELLA DISSEMINATA PERS.

By Professor A. H. Reginald Buller, D.Sc., Ph.D., F.R.S.C.

Introductory Remarks.—During the last ten years, I have made a series of investigations upon the structure and mode of functioning of the fruit-bodies of numerous species of the genus Coprinus. In 1909 in the first volume of my "Researches on Fungi," I gave an account of the mechanism for the production and liberation of spores in *Coprinus comatus*,* and in 1910 a similar account for *Coprinus atramentarius*.† In the latter, stress was placed on the function and fate of the cystidia. In 1911, I supplemented these studies with a communication on the production and liberation of spores in the genus Coprinus,‡ and then, in 1913, pointed out how the spore-producing mechanism of Bolbitius differs from that of Coprinus.§ A fortnight before the war broke out, I sent a fully illustrated paper called "The Production and Liberation of spores in *Coprinus sterquilinus*" to Germany for publication in Pfeffer's *Festschrift* (Volume LXVI of the *Jahrbücher für wissenschaftliche Botanik*). This paper, under the direction of Professor Klebs, was translated into German and published in the *Festschrift* in 1915.

By means of the investigations just indicated, I have gained a clear conception of the nature of the genus Coprinus and now feel in a position to decide whether or not any given Agaric should be regarded as a Coprinus.

* Longmans, Green and Co., London, pp. 196-215.

† The Function and Fate of the Cystidia of *Coprinus atramentarius*, together with some General Remarks on Coprinus Fruit-Bodies, Annals of Botany, Vol. XXIV., pp. 613-629.

‡ The Production and Liberation of Spores in the Genus Coprinus, Transactions of the British Mycological Society, Vol. III., 1911, pp. 348-350.

§ The Fruit-body Mechanism of Bolbitius, *ibid.*, Vol. IV., 1913, pp. 235-238.

The chief points in connection with the mechanism for the production and liberation of spores in the genus Coprinus are as follows:—

(1) The gills are very thin,
(2) The gills are parallel-sided or subparallel-sided,
(3) The gills are not positively geotropic,
(4) Usually the hymenium on one side of a gill at maturity looks slightly downwards and that on the other side slightly upwards,
(5) The spores ripen in succession from below upwards on each gill,
(6) The spores are discharged in succession from below upwards on each gill,
(7) Autodigestion proceeds from below upwards on each gill and removes those parts of the gills which become spore-free and which, if they continued in existence, would become mechanical hindrances to the fall of the remaining spores.

All the facts just given are correlated with one another. In the genus Coprinus the ripening and discharge of the spores from below upwards on each gill, and the autodigestion from below upwards on each gill, are special arrangements which permit of successful spore-discharge from parallel-sided, non-geotropic gills.

By contrast, the chief points in connection with the mechanism for the production and liberation of spores in non-Coprinus Agaricineae, such as the species of Amanita, Psalliota, Panaeolus, &c., are as follows:—

(1) The gills are sometimes very thin but are usually relatively thick,
(2) The gills are not parallel-sided but are more or less acutely wedge-shaped in cross-section,
(3) The gills are positively geotropic,
(4) Every part of the hymenium on any gill in a normally oriented fruit-body looks more or less downwards,
(5) The spores do not ripen in succession from below upwards on each gill but more or less uniformly all over the gill surfaces,
(6) The spores are not discharged in succession from below upwards on each gill, but more or less uniformly all over the gill surfaces.
(7) Autodigestion does not proceed from below upwards on each gill or involve any part of a gill during the period of spore-discharge.

In the light of these criteria, let us now consider the generic positions attributed to the three fungi named in the title of this paper.

Psathyra urticaecola Berk. et Broome.—Whilst hunting for fungi in Queen's Cottage Grounds at Kew Miss E. M. Wakefield and I found this species growing on sticks and other rubbish which had been dredged from the large lake in the Royal Gardens, and also on dead leaves and haulms of *Holcus lanatus* L. On one stick there were from twenty to thirty fruit-bodies which at the time were from one-quarter to one-third of an inch in height. At the Herbarium Mr. Massee at once recognised the fungus as *Psathyra urticaecola,* and this view was supported by other mycologists working there. The correctness of the identification is supported by the original description of the species as given by Berkeley and Broome,* which I find to be as follows :—

"*A.* (*Psathyra*) *urticaecola,* n.sp. Pileo campanulato, margine striato, stipiteque sursum attenuato, fistuloso, insititio flocculentis albis; lamellis antice ventricosis, postice attenuatis, ex albo spadiceis.

On nettle-roots. King's Cliffe, Aug. 8, 1858.

Pileus 2 lines across, campanulate, flocculent, white; margin at length straight, striate; stem short, slender, attenuated upwards, flocculent, fistulose, springing immediately from the matrix; gills ventricose in front, attenuated behind, adnexed, at first white, then a rich chocolate.

Allied to *A. pennatus.*"

The specimens which Berkeley and Broome deposited in the Kew Herbarium are so shrivelled that they were found to be of little or no value in assisting identification of the living fungi; but it was noted that Berkeley had added a note upon the specimen sheet, which contained a description of the species in English similar to that just quoted and also the following additional remark :—

"Allied to *A. pennatus* but gills by no means black; habit of a Coprinus or *A. sericellus.*" Finally, there was a pencil note on the sheet showing an oval spore and a description of the spores as "brown with a very slight purple tinge."

The King's Cliffe specimens are illustrated in Plate 596 of Cooke's *Illustrations of British Fungi,* and the size of the spores is there given as $7 \times 4\mu$.

From the above description, notes, and illustrations, I was able to convince myself that the fungus which I had collected at Kew was identical with *Psathyra urticaecola* Berk. et Broome.

I discovered that the supposed Psathyra is in reality a Coprinus. The sticks on which the young fruit-bodies were

* Berkeley and Broome, Notices of British Fungi, Ann. and Mag. of Nat. Hist., May and June, 1861.

growing were placed in a damp chamber. The fruit-bodies underwent autodigestion in the following night. Several other crops of fruit-bodies subsequently came up, and each of them shed their spores and became reduced by autodigestion in the night. On examining the fruit-bodies with the microscope, I found that all the seven criteria already given for the genus Coprinus were satisfied. The gills of the pileus are (1) exceedingly thin, for they scarcely exceed 0.1mm. in thickness, (2) parallel-sided, and (3) non-geotropic, for they are held together in a solid mass in the same way as in *Coprinus atramentarius*. Since the gills are parallel-sided, non-geotropic, and closely packed, it must of necessity happen that (4) one side of a gill looks slightly upwards and the other slightly downwards. The spores were observed (5) to ripen and (6) be discharged from below upwards on each gill; and, finally (7), typical coprinoid autodigestion was seen to take place: the gills were gradually destroyed from below upwards, the spore-free portion being liquefied and thus gradually removed out of the way of the falling spores.

As we have seen, Berkeley remarked on the Kew herbarium sheet that *Psathyra urticaecola* has "the habit of a Coprinus." The reason why Berkeley and Broome failed to discover that this fungus is a Coprinus and not a Psathyra is probably because the autodigestion of the gills takes place at night. I found that the gills are white in the morning but turn chocolate from below upwards with the ripening of the spores during the afternoon, and that spore-discharge takes place in the evening and night. By the following morning the fruit-bodies are exhausted and falling.

The spores, like those of several other very small species of Coprinus, are not jet black but distinctly chocolate-coloured. They measure $7 \times 4\mu$ and are oval. The top of the pileus is chalky white and beset with flocculent masses of matted hyphae. The cystidia are cylindrical-oval and are firmly fixed by both ends into opposing gills which they bridge as in *Coprinus atramentarius*. The basidia are dimorphic as is usual for Coprini; but the long and short basidia are rather freely spaced. The paraphyses are distinctly pedicellate.

The following description may now be given of the fungus:—

Coprinus urticaecola (Berk. et Broome) Buller, new combination. Pileus about 5 mm. in diameter in the hemisperical condition, almost spherical at first, becoming hemispherical at the time the spores begin to ripen, opening out and even becoming revolute and radially split during the discharge of the spores, chalky white, unstriate, beset with numerous small white scales composed of matted hyphae

unmixed with globular cells and not bearing crystals of calcium oxalate. Gills very thin, about 0.1—0.15mm. thick, ventricose, maximum width 1.5 mm., at first white then becoming chocolate, the colouration proceeding from below upwards, held together by cylindrical-ovate cystidia which cross the interlamellar spaces as in *Coprinus atramentarius* and undergo complete autodigestion in the evening and night. Stipe when fully elongated 1.5-2 cm. high, 2 mm. thick below, attenuated upwards, scarcely more than 1 mm. thick at the top, white, flocculent at the very base otherwise smooth, when pulled from the wood to which it is attached leaves a small discoid piece of itself behind, hollow. Spores minute, $7 \times 4\mu$, oval, smooth. Spore-discharge and autodigestion of the gills take place in the evening and night.

On sticks, also on dead leaves and haulms of a grass (*Holcus lanatus* L), Queen's Cottage Grounds, Kew, June, 1912.

Coprinus plicatilis Pers. Massee,* in 1906, stated that "Many species included in Coprinus, as *C. plicatilis* and others having dry non-deliquescent gills, have no real affinity with this genus;" and on mycological excursions I have heard the suggestion put forward that *C. plicatilis* is rather a Psathyrella than a Coprinus. The true generic position of this fungus therefore appears to be a matter of some doubt.

For a number of years I have had excellent opportunities for examining the structure and mode of spore-discharge of the species in question. I find that all the seven criteria for a Coprinus are satisfied except one: there is no autodigestion of the gills from below upwards. The gills are (1) very thin, for they are not more than 0.15mm. thick, (2) parallel-sided, and (3) non-geotropic, a fact decided by experiment. Since the gills are parallel-sided and non-geotropic, it must of necessity happen that (4) one side of a gill looks slightly upwards and the other slightly downwards. I have convinced myself that (5) the spores ripen in succession from below upwards on each gill and that (6) the spores are discharged in succession from below upwards on each gill; but microscopical as well as macroscopical examination shows that autodigestion does not proceed from below upwards on each gill. Massee truly described the gills as being dry and non-deliquescent.

I regard *Coprinus plicatilis* as a Coprinus which has lost one of its chief Coprinus characters, namely, autodigestion; but I do not hesitate to retain the fungus in the genus

* G. Massee, Text-Book of Fungi, London, 1906, p. 364.

Coprinus, because with this exception all the characters are coprinoid. In no other genus than Coprinus do the spores ripen and become discharged from below upwards on the gills.

The basidia are trimorphic as a rule, but here and there on a gill they may be dimorphic. The long and short basidia, together with the pavement-like paraphyses, have the normal coprinoid arrangement. The zones of spore-discharge are unusually wide but they nevertheless proceed from below upwards on each gill. The loss of autodigestion is doubtless associated with the fact that as the pileus opens it becomes spread out like a parasol. The gills split along their median planes from above downwards and thus become **Y**-shaped in vertical transverse section. The upper parts of the gills thus come to look downwards and the spores there discharged can escape freely from the pileus without any danger of striking an obstacle. It is noticeable, however, that one side of the unsplit lower portion of a gill is often powdered black with spores which have failed to gain their freedom. This appears to be due to the fact that the side so powdered has looked slightly upwards and has therefore caught the spores on its surface after they have been shot away from its hymenium and have fallen vertically for a certain distance. The loss of autodigestion is therefore associated with a certain loss of efficiency in spore-discharge.

In certain other small Coprini, *e.g.*, *Coprinus ephemerus* Fr., the pileus also opens out parasol-wise before spore-discharge begins and each gill becomes **Y**-shaped in cross-section. However, in all these species the lower part of the vertical portion of each gill distinctly undergoes autodigestion which can be observed either with the eye or with the microscope, so that in these cases the most characteristic feature of the mechanism of Coprinus fruit-bodies has not been eliminated. My investigations upon numerous small species of the genus Coprinus have convinced me that *Coprinus plicatilis* alone has lost the power of reducing its gills by autodigestion during spore-discharge; and I therefore cannot agree with Massee when he states that *many* species included in the genus Coprinus have dry and non-deliquescent gills.

There is a fungus which has come up spontaneously on horse-dung several times in my laboratory at Winnipeg. It so much resembles the *Coprinus plicatilis* which occurs in such abundance in grassy fields in England, that at first I thought that the two species were identical; but a careful comparison has convinced me that they are distinct. The two fungi are similar in their brownish colour when young, in their umbonate disc becoming depressed at maturity, in

the collar formed by the inner ends of the gills around the top of the stipe, and in the black colour, almost identical size, and the shape of the spores. However, the Winnipeg species differs from *Coprinus plicatilis* in having (1) a somewhat browner pileus in the expanded condition, in (2) having a somewhat longer stipe relatively to the breadth of the pileus, in (3) growing on horse-dung instead of on grassy turf, but especially in (4) the fact that the lower portion of the vertical part of each gill undergoes a slight but quite definite amount of autodigestion from below upwards during the period of spore-discharge. The Winnipeg species which may be new and as yet undescribed, is evidently a Coprinus, and it serves to connect *Coprinus plicatilis* with the more typical Coprini, such as *Coprinus fimetarius, C. niveus* and others in which autodigestion of the gills from below upwards is a very obvious and striking character.

Psathyrella disseminata Pers. Lange has recently published a monograph on the genus Coprinus in which he has described in detail thirty-three species which have been found growing in Denmark.* In his section *Nudi,* he includes two fungi which Fries regarded as Psathyrellae, namely, *Coprinus disseminatus* (Pers.) Quél., which Fries called *Psathyrella disseminata,* and *Coprinus impatiens* (Fr.) Quél., which Fries called *Psathyrella impatiens.* The latter species I have not so far had an opportunity of examining but to the former I have paid considerable attention. Every field mycologist knows that this fungus often comes up by hundreds in autumn upon and around old tree stumps.

I have no doubt whatever that Lange is in error in placing *Psathyrella disseminata* in the genus Coprinus. If one examines the gills carefully with the microscope, one finds that they satisfy the seven criteria for a non-Coprinus, lamellate fungus, possibly with the exception of the third. The gills are (1) thin but (2) they are acutely wedge-shaped in cross-section. Whether or not they are (3) positively geotropic I do not know. However, every part of the hymenium on any gill in a normally oriented fruit-body looks more or less downwards, for the stipe, by means of a very precise negative geotropic reaction brings the median planes of all the gills into approximately vertical positions. The most important criteria are the fifth, sixth, and seventh. The spores (5) do not ripen in succession from below upwards on each gill but more or less uniformly all over the gill surfaces.

* Jakob E. Lange, Studies in the Agarics of Denmark, Dansk Botanisk Arkiv udgivet af Dansk Botanisk Forening, Part II., No. 3, 1915, pp. 46-47.

The spores (6) are not discharged in succession from below upwards on each gill but more or less uniformly all over the gill surfaces. Finally (7), autodigestion does not proceed from below upwards on each gill or involve any part of a gill during the period of spore-discharge. The collapse of the gill and pileus as a whole takes place only when spore-discharge has ceased. *Psathyrella disseminata* is therefore not a Coprinus; and, for the present at least, there is no good reason for changing its generic position from that given to it by Fries.